

This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

**As rescanning documents *will not* correct images,
please do not report the images to the
Image Problem Mailbox.**

FIG 1

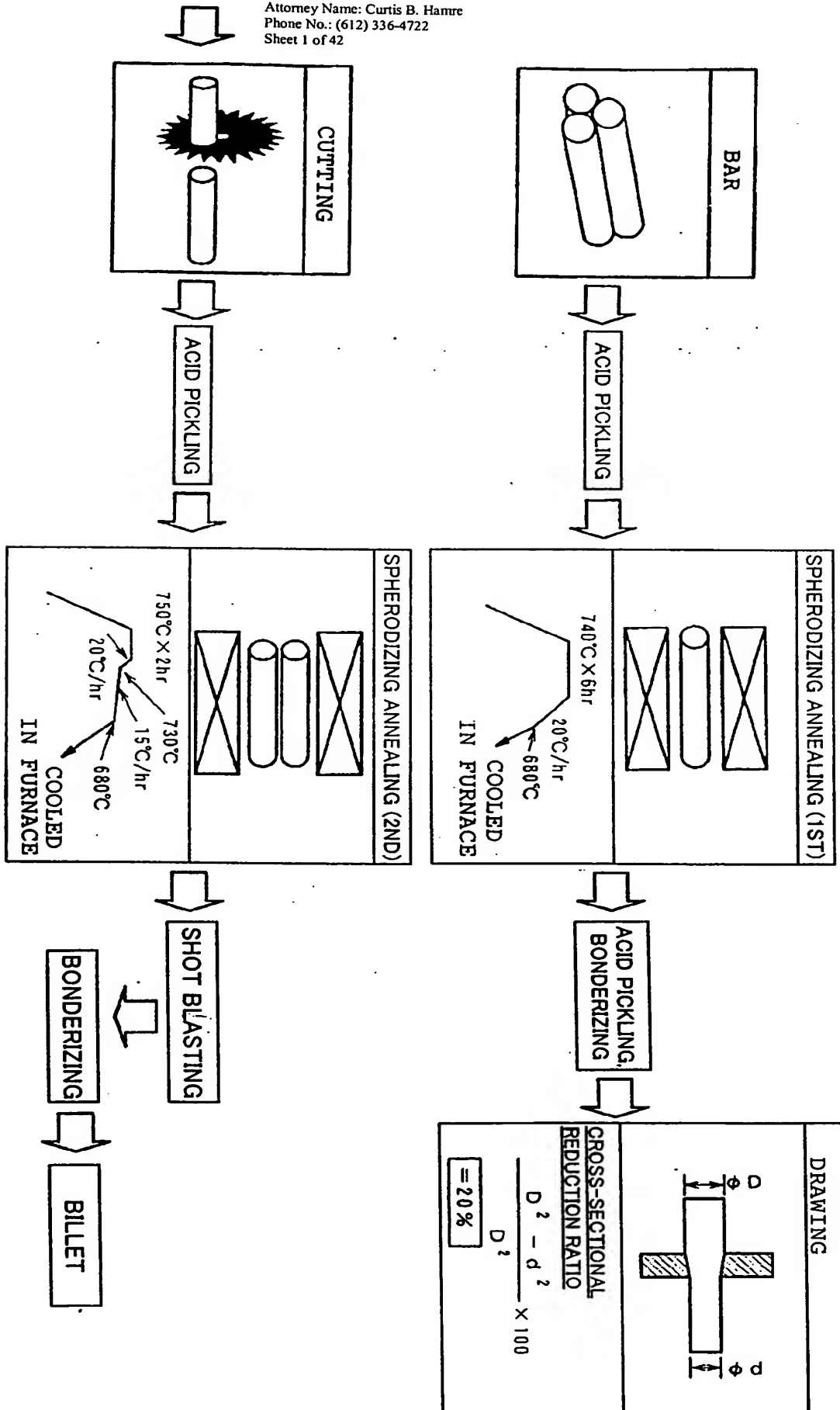


FIG. 2

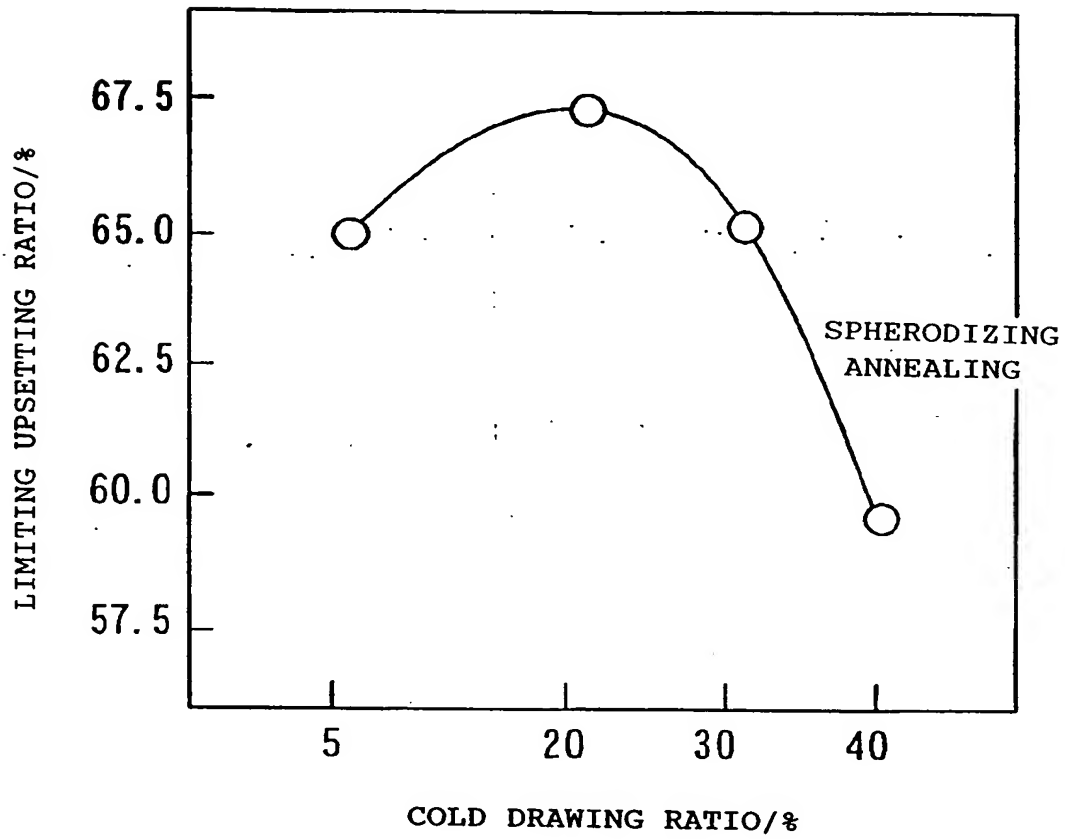
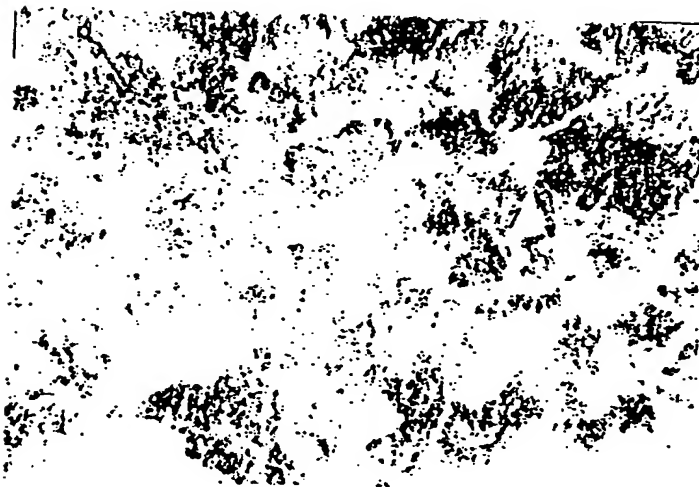


FIG. 3

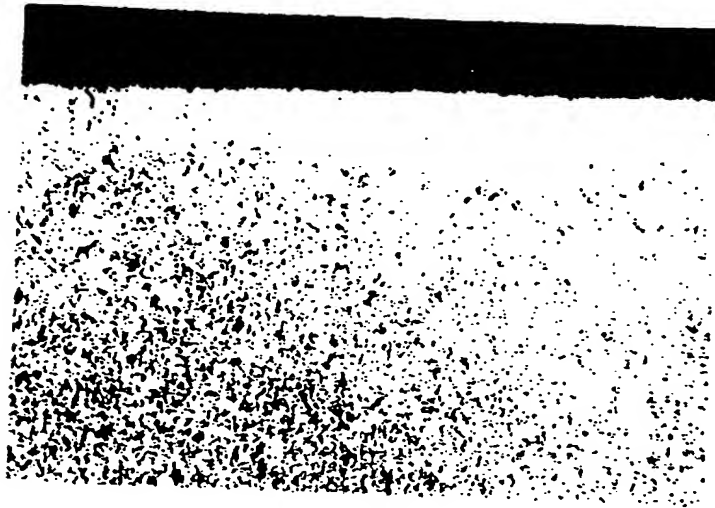


(a)

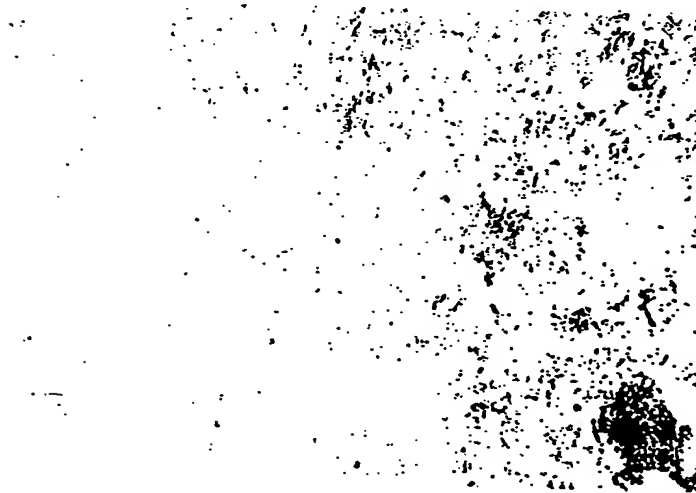


(b)

FIG. 4

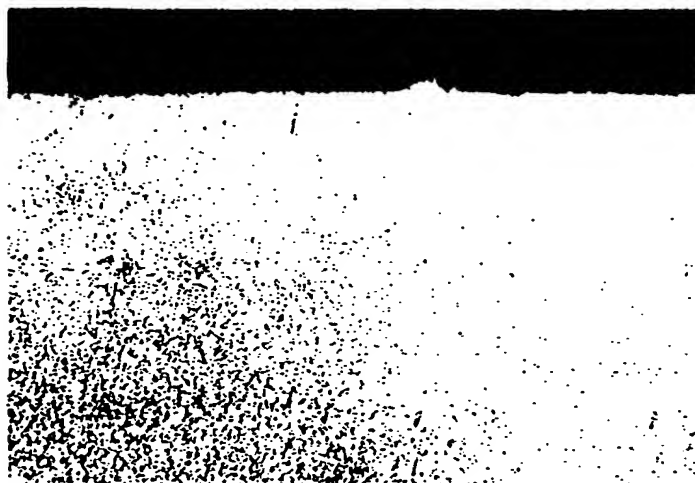


(a)



(b)

FIG. 5



(a)



(b)

FIG. 6

(A) MATERIAL 1

ASPECT RATIO = 506 %



(B) MATERIAL 2

ASPECT RATIO = 347 %



(C) MATERIAL 3

ASPECT RATIO = 300 %

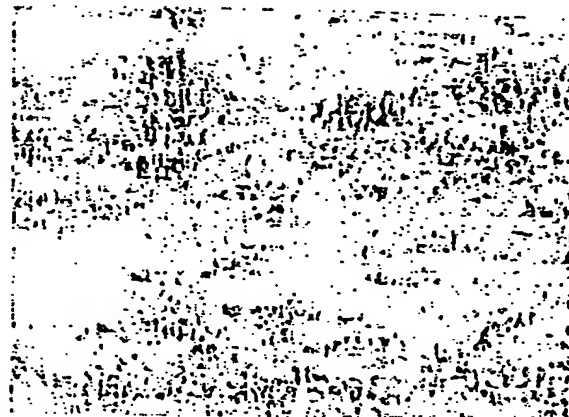


FIG. 7

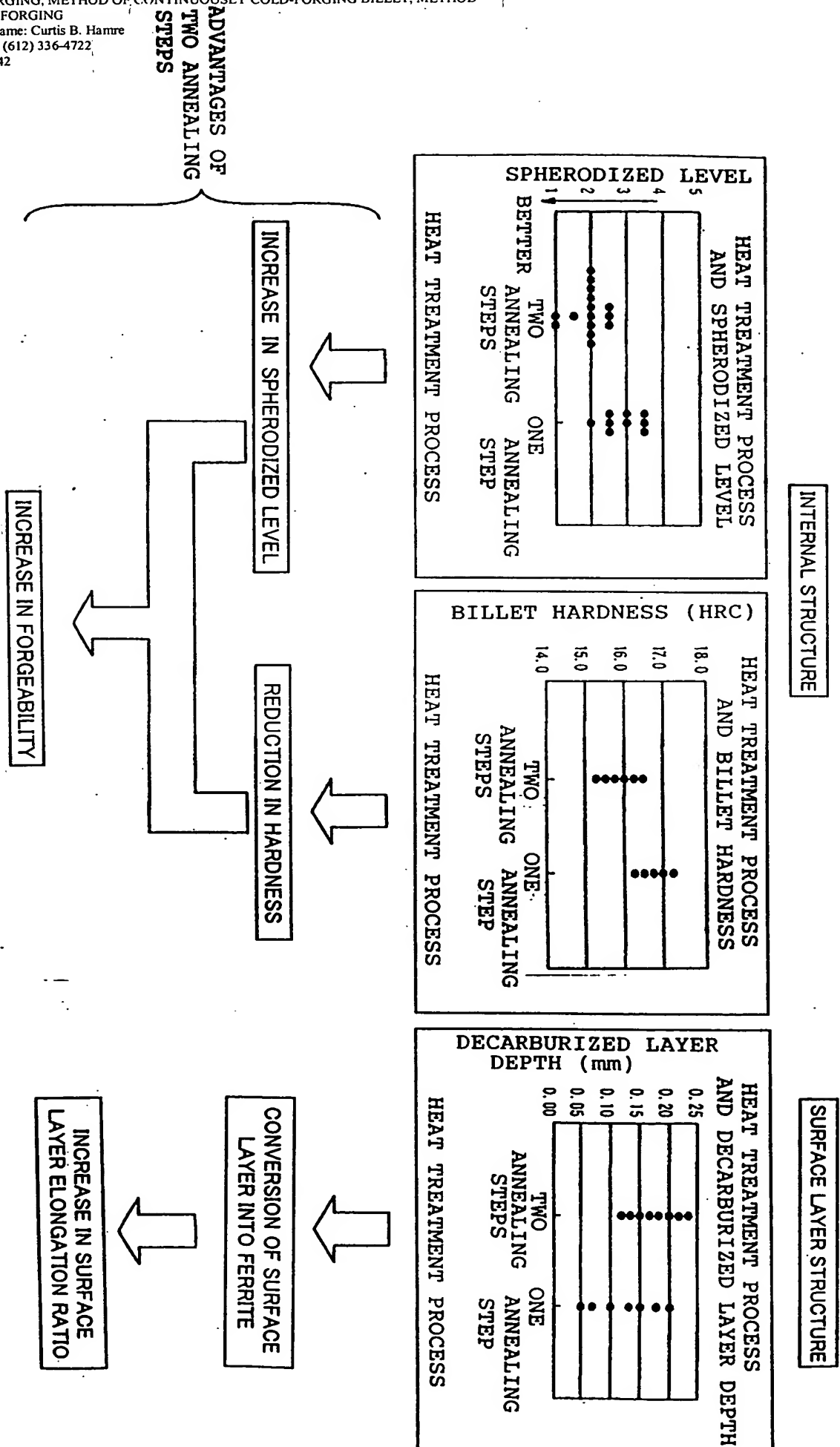


FIG. 8

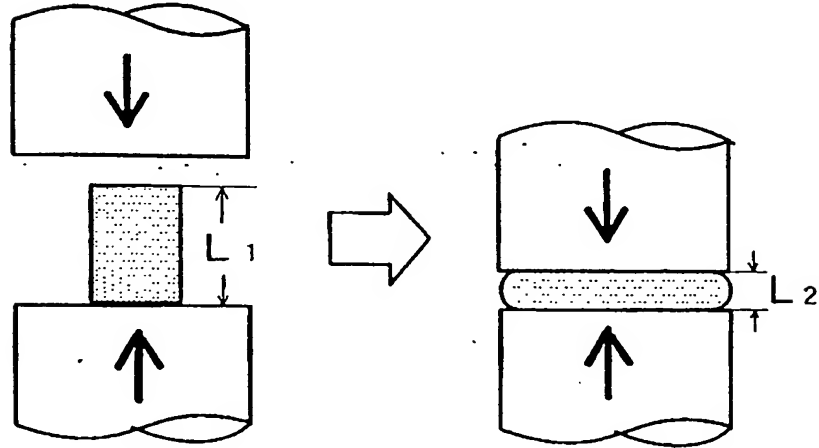


FIG. 9

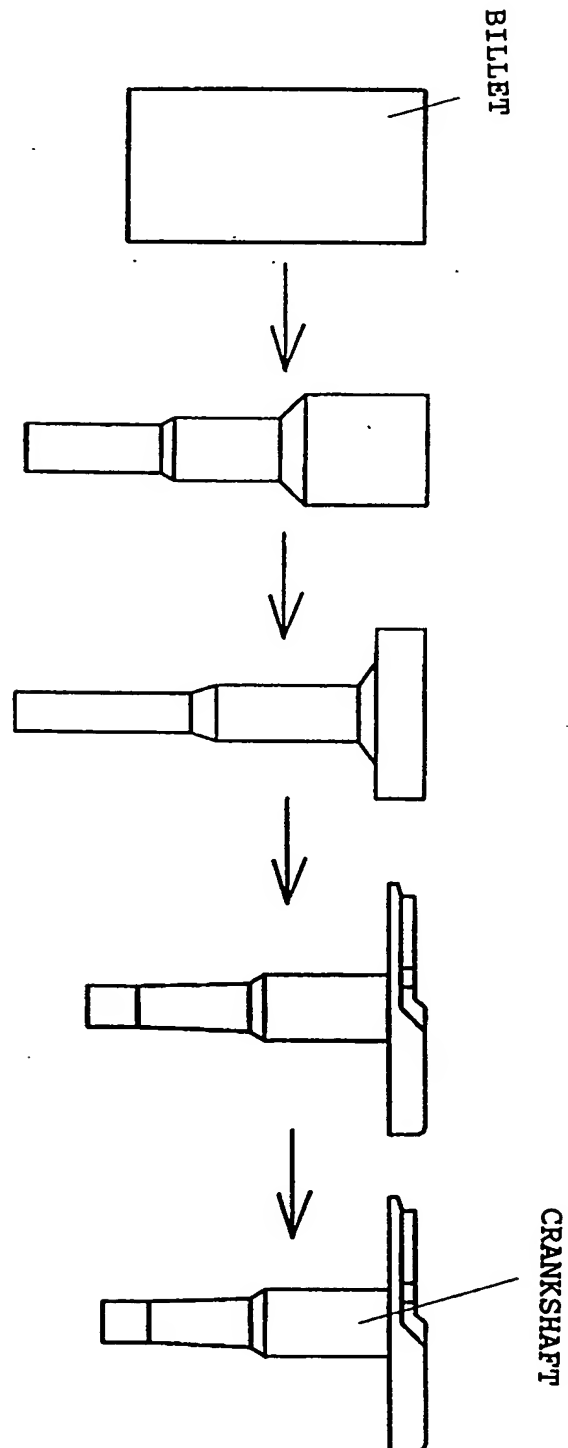


FIG. 10

Inventor: Ando, et al
Docket No.: 12052.33USD2
Title: BILLET FOR COLD FORGING, METHOD OF MANUFACTURING BILLET FOR COLD FORGING, METHOD OF CONTINUOUSLY COLD-FORGING BILLET, METHOD OF COLD-FORGING
Attorney Name: Curtis B. Hamre,
Phone No.: (612) 336-4722
Sheet 10 of 42

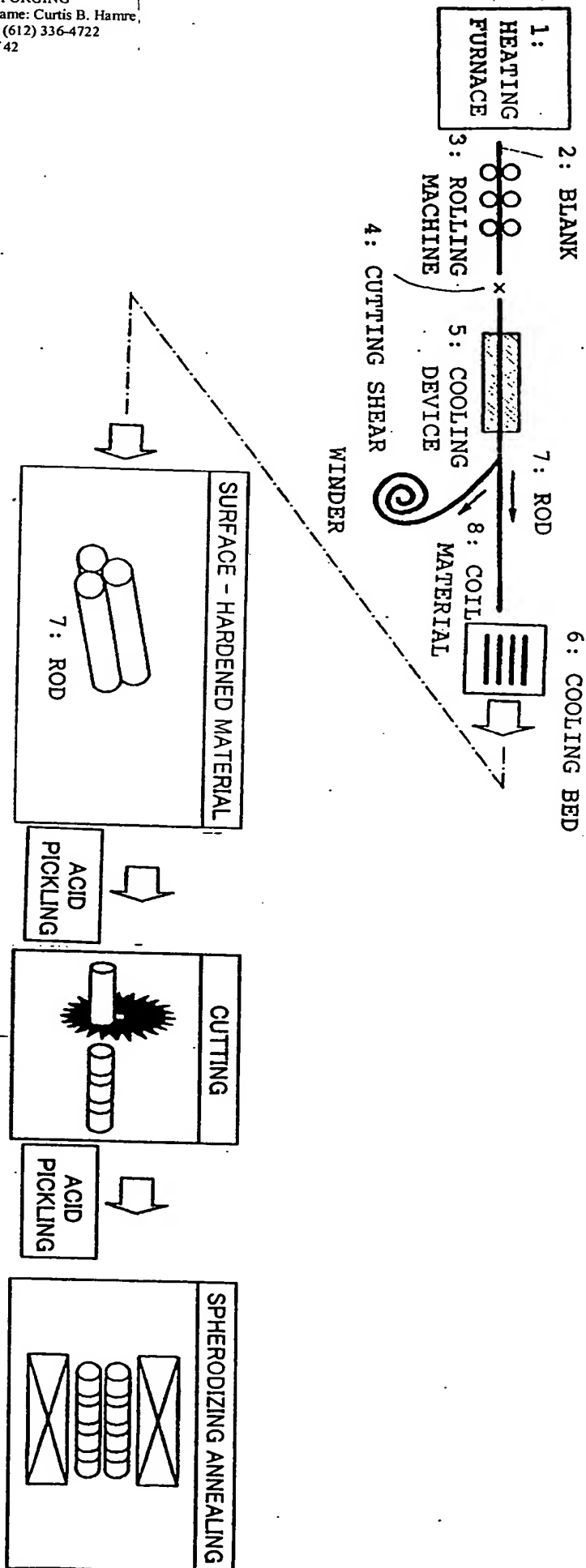


FIG. 11

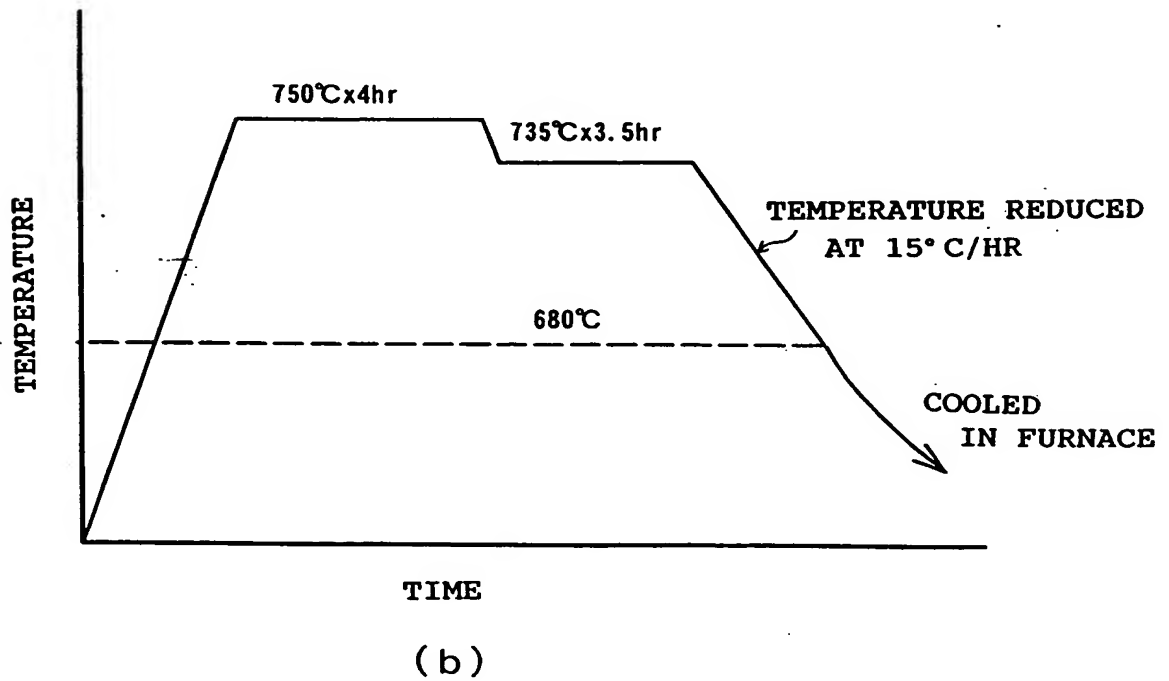
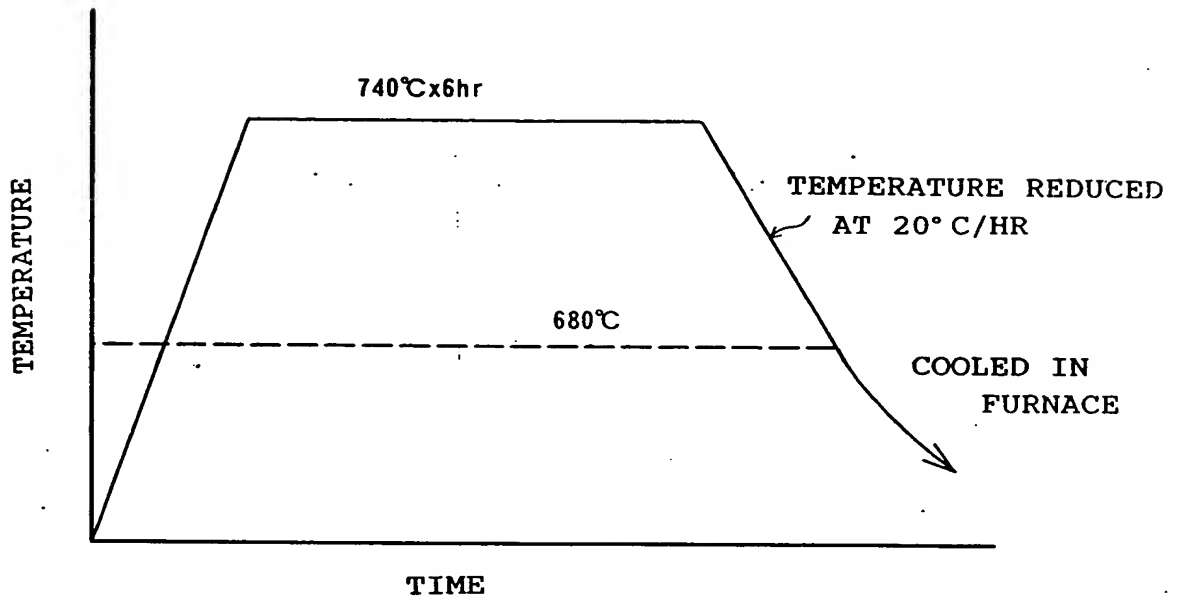
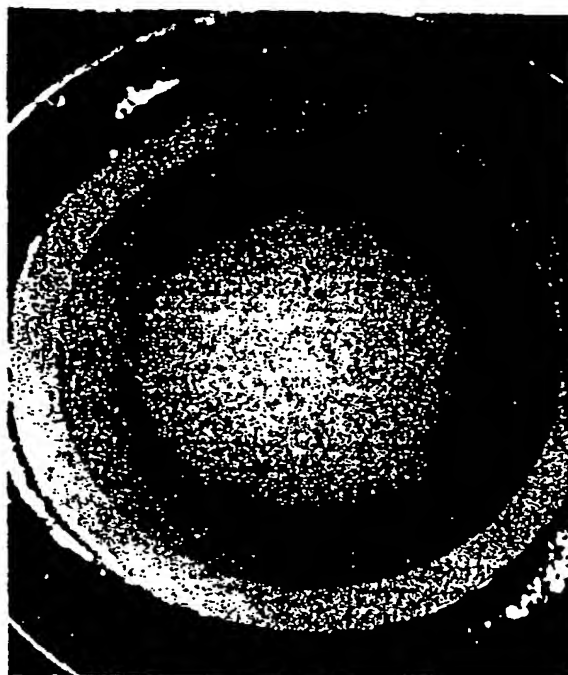


FIG. 12



MARTENSITIC MATERIAL
(a) PRIOR TO SPHERODIZING ANNEALING
× 2. 1

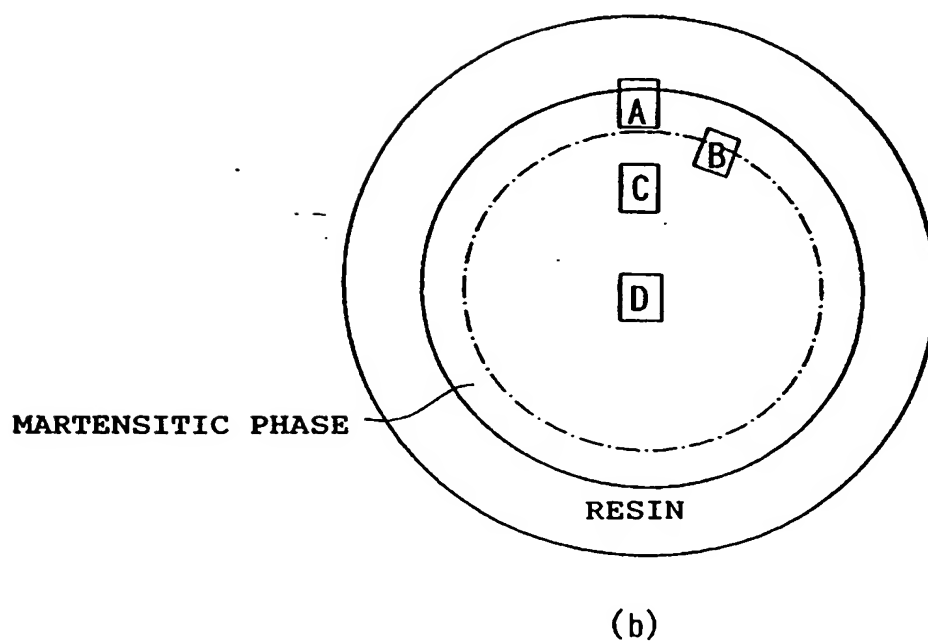
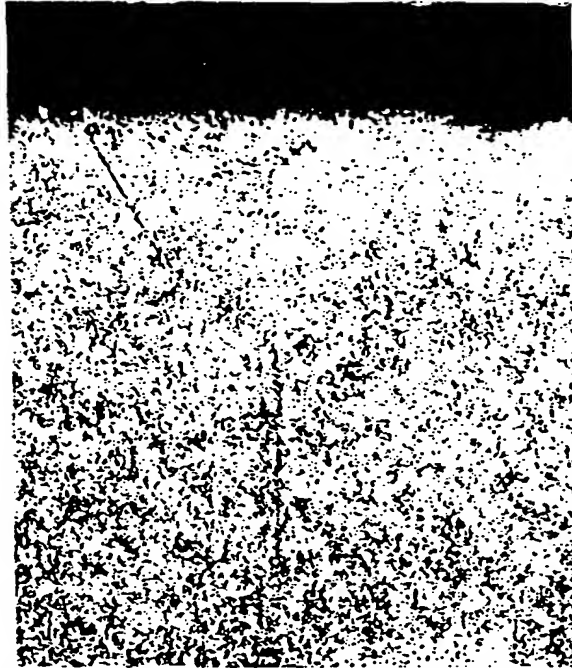
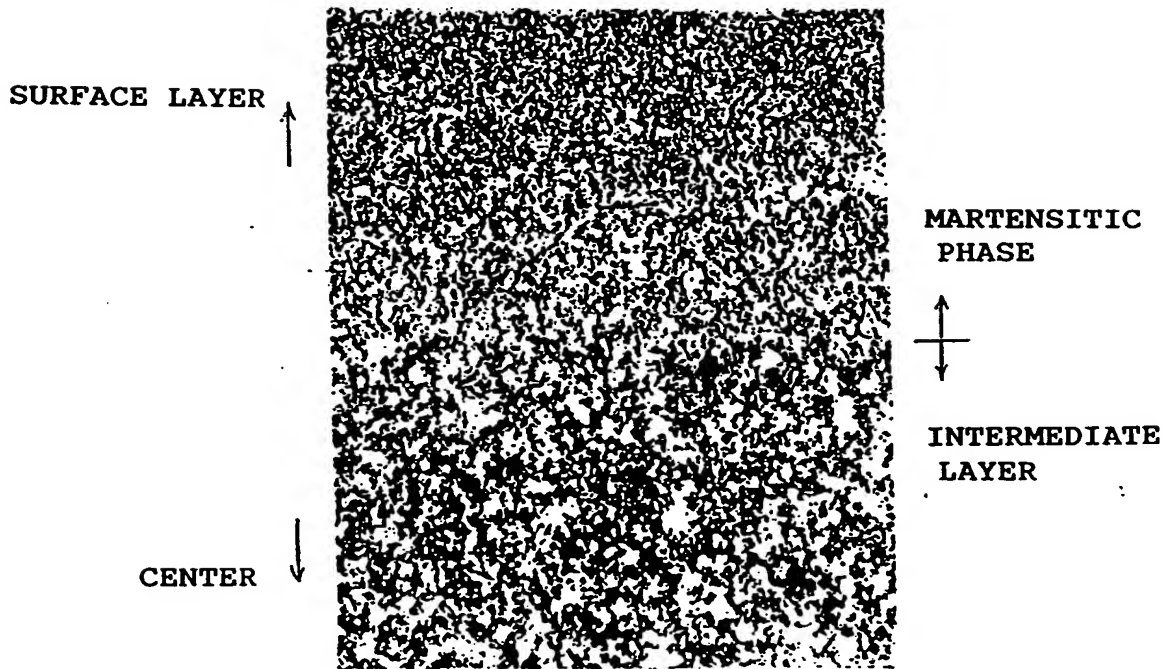


FIG. 13



PRIOR TO SPHERODIZING ANNEALING
SURFACE LAYER $\times 100$

FIG. 14



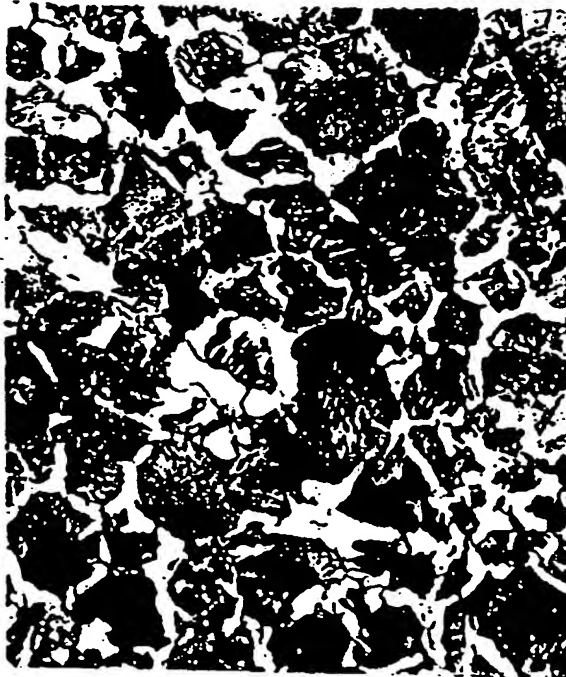
PRIOR TO SPHERODIZING ANNEALING
SURFACE LAYER AND INTERMEDIATE LAYER $\times 200$

FIG. 15



PRIOR TO SPHERODIZING ANNEALING
1/2 R PART $\times 400$

FIG. 16



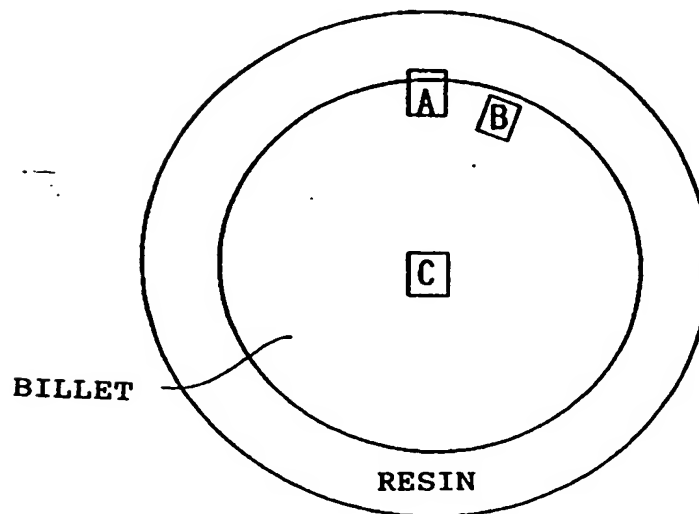
PRIOR TO SPHERODIZING ANNEALING
CENTRAL PART $\times 400$

FIG. 17



MARTENSITIC MATERIAL
AFTER SPHERODIZING ANNEALING PATTERN 1
x 2. 1

(a)



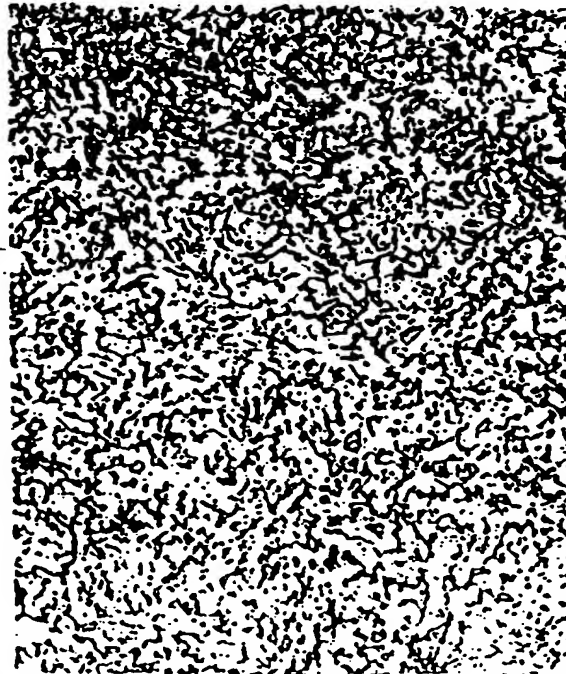
(b)

FIG. 18



AFTER SPHERODIZING ANNEALING PATTERN 1
SURFACE LAYER $\times 100$

FIG. 19



AFTER SPHERODIZING ANNEALING PATTERN 1
SURFACE LAYER $\times 400$

FIG. 20



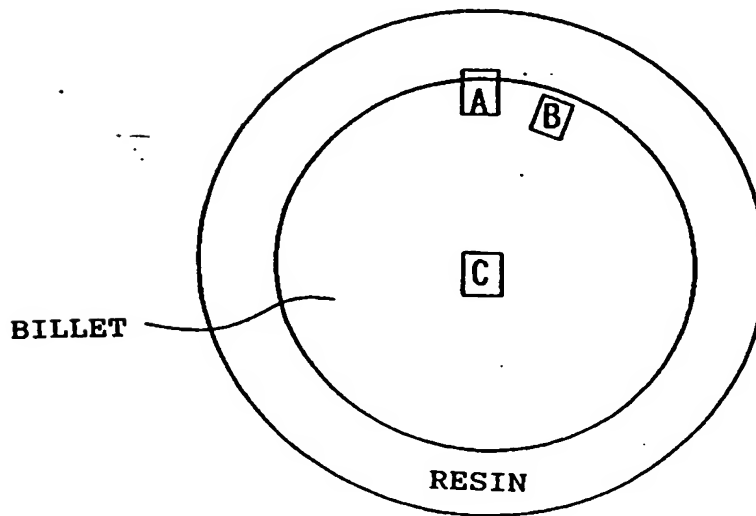
AFTER SPHERODIZING ANNEALING PATTERN 1
1/2 R PART \times 400

FIG. 21



MARTENSITIC MATERIAL
AFTER SPHERODIZING ANNEALING PATTERN 2
x 2. 1

(a)



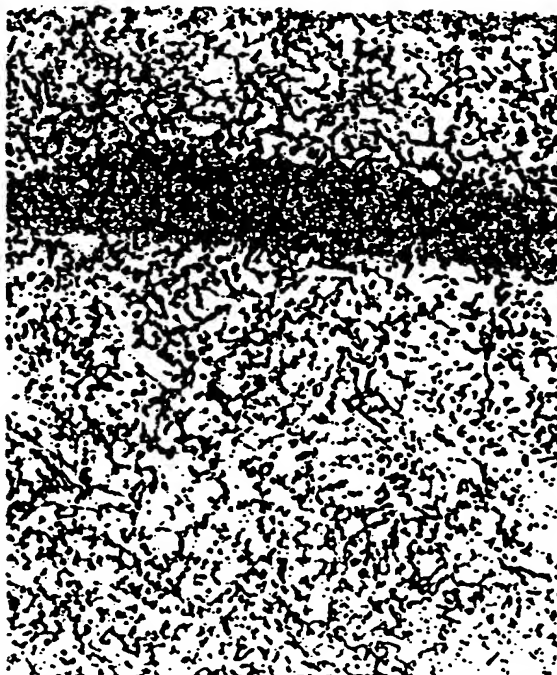
(b)

FIG. 22



AFTER SPHERODIZING ANNEALING PATTERN 2
SURFACE LAYER $\times 100$

FIG. 23



AFTER SPHERODIZING ANNEALING PATTERN 2
SURFACE LAYER $\times 400$

FIG. 24



AFTER SPHERODIZING ANNEALING PATTERN 2
1/2 R PART \times 400

FIG. 25

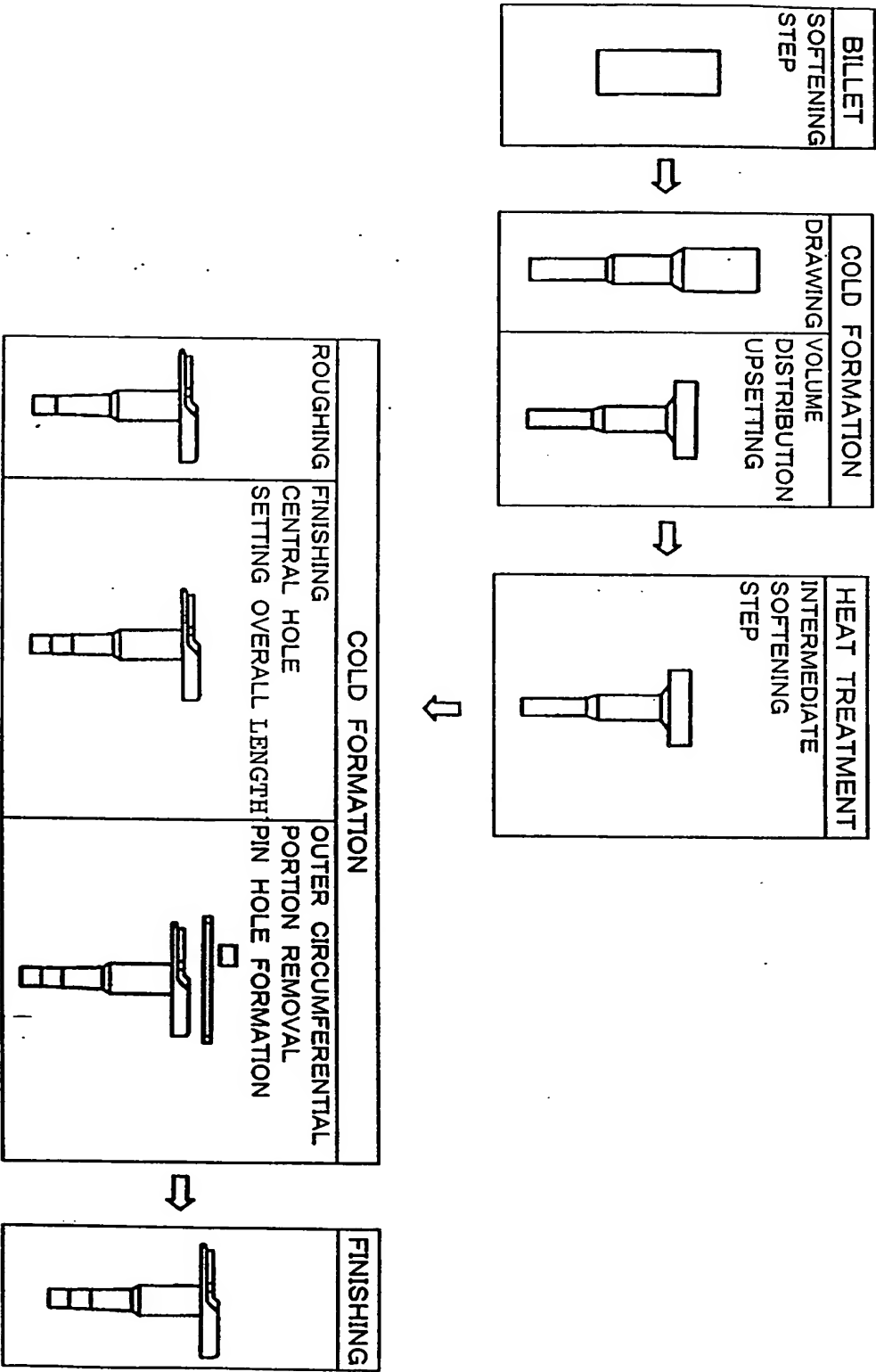


FIG. 26

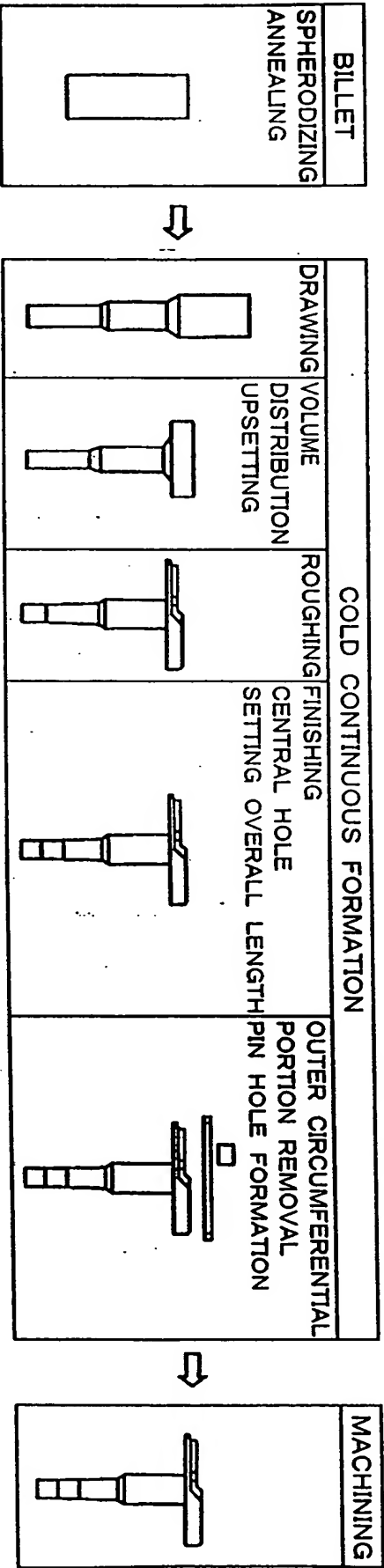


FIG. 27

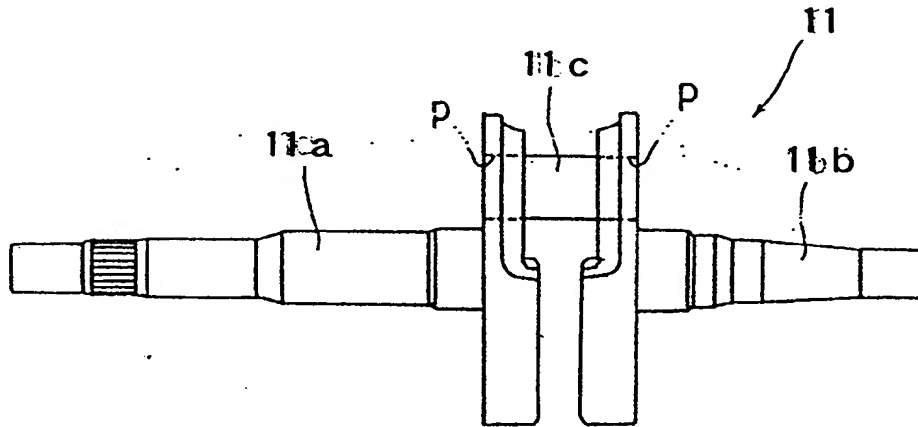


FIG. 28

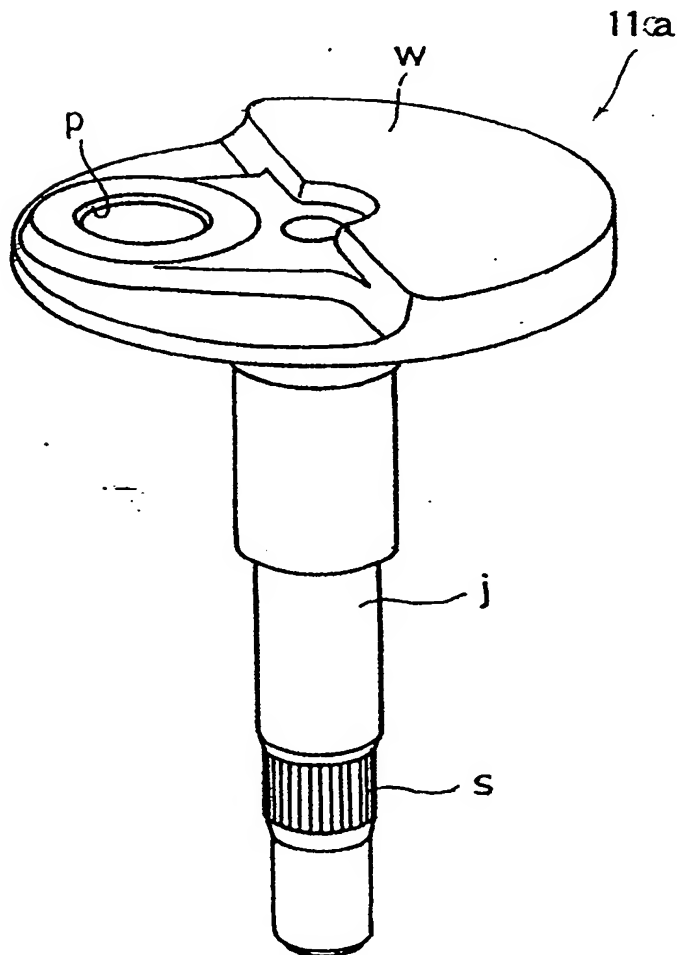


FIG. 29

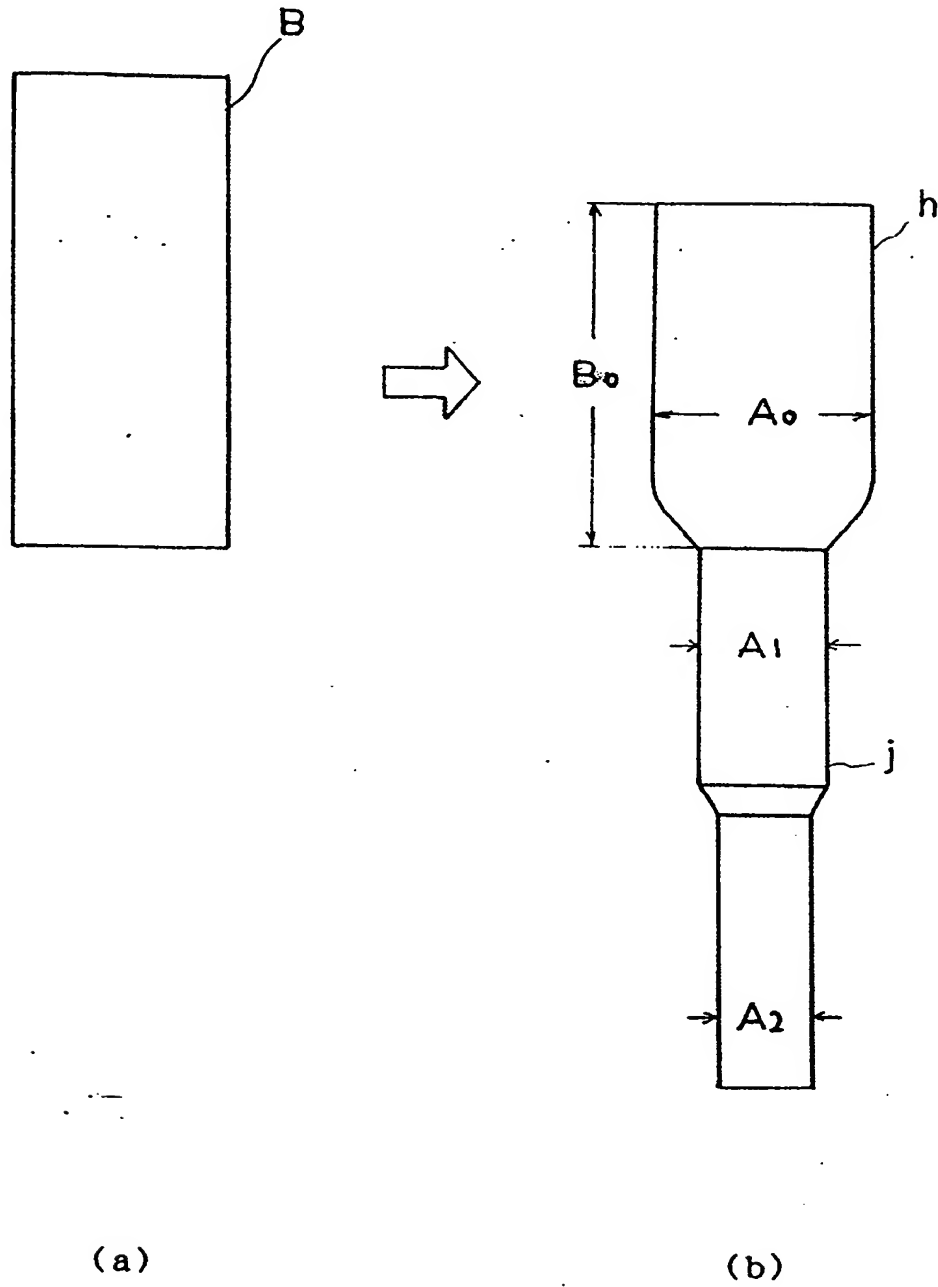


FIG. 30

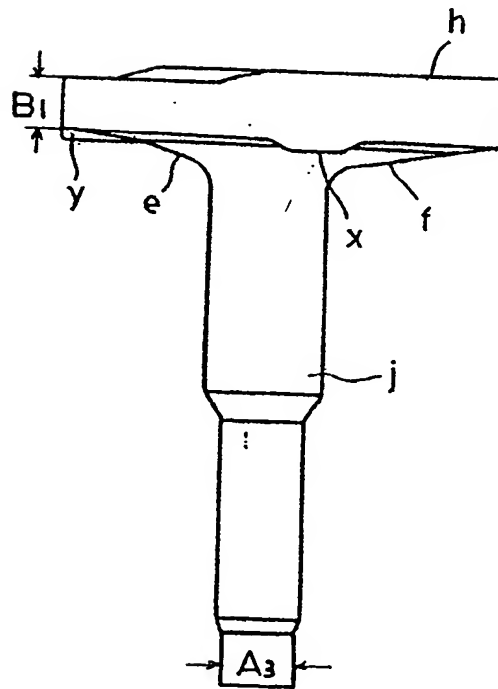
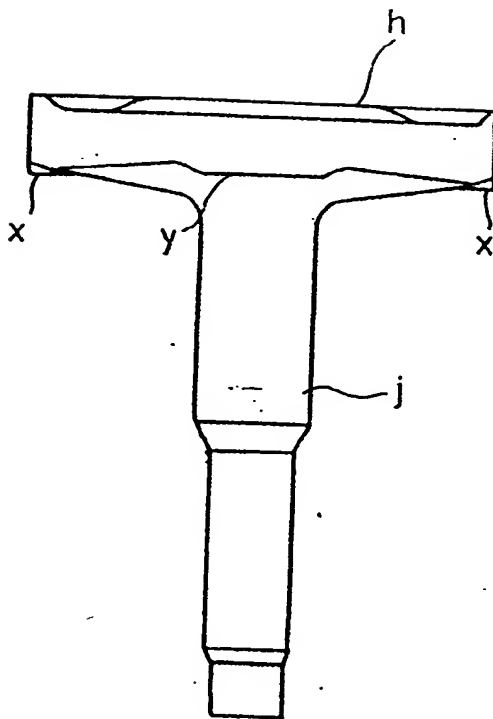
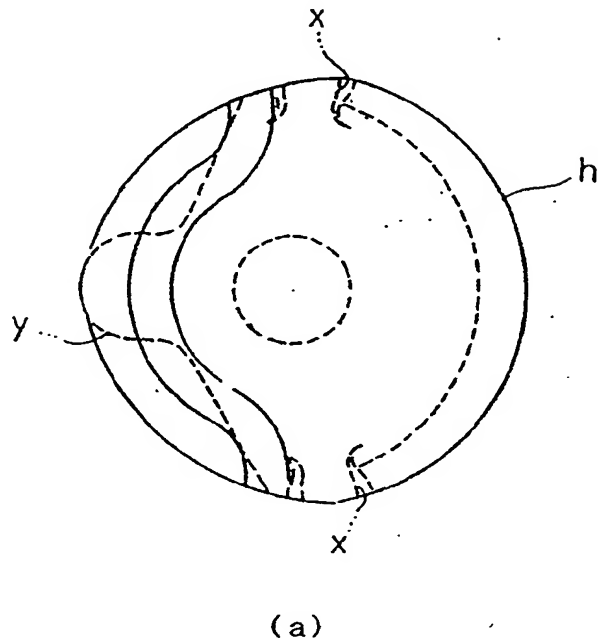
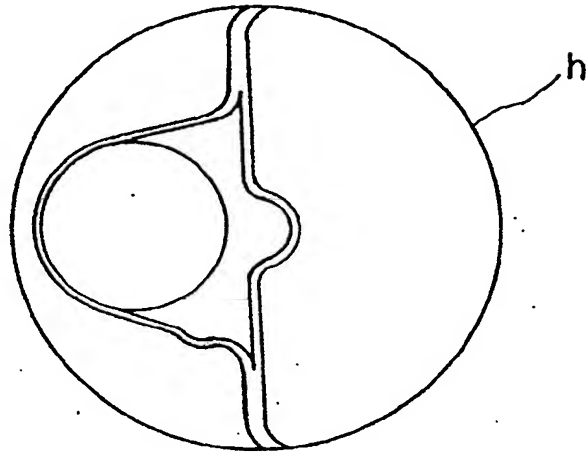
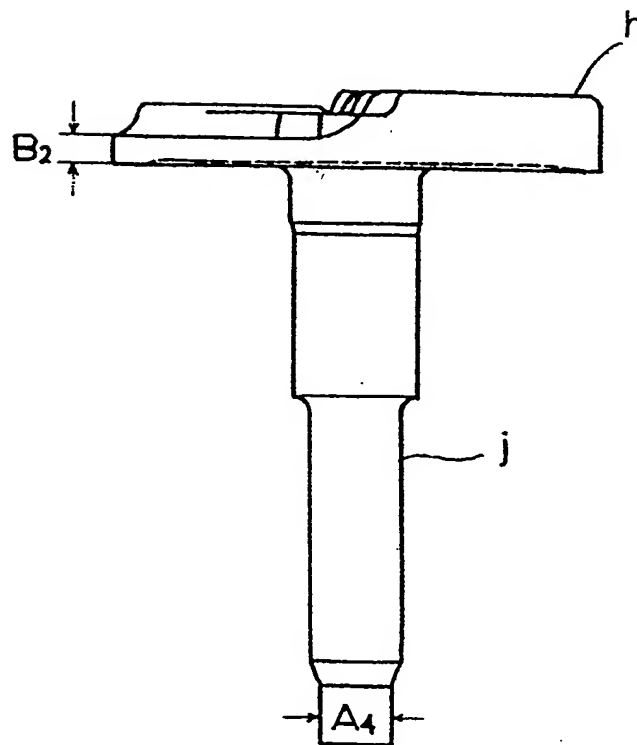


FIG. 31

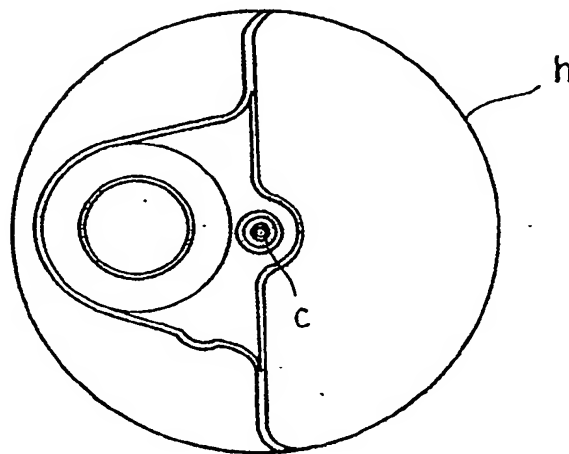


(a)

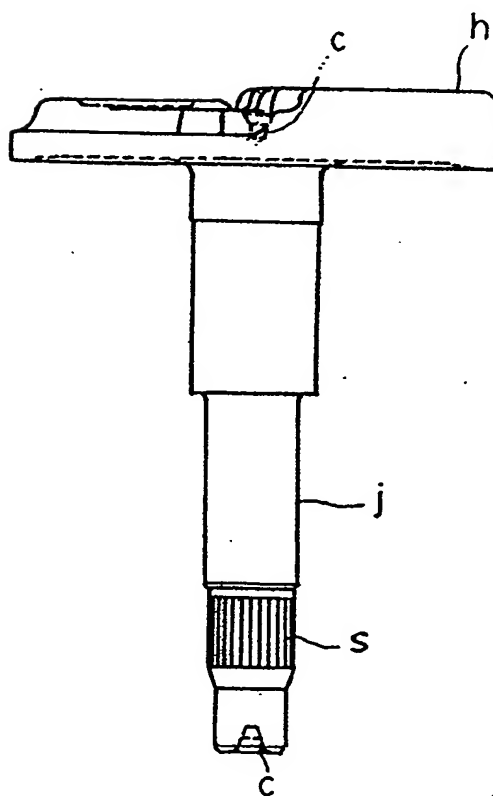


(b)

FIG. 32

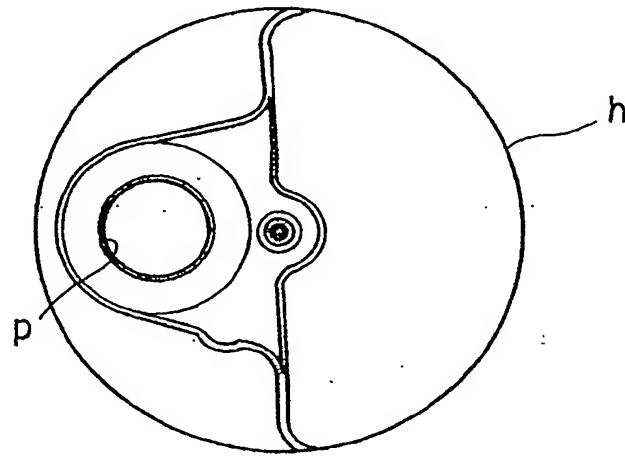


(a)

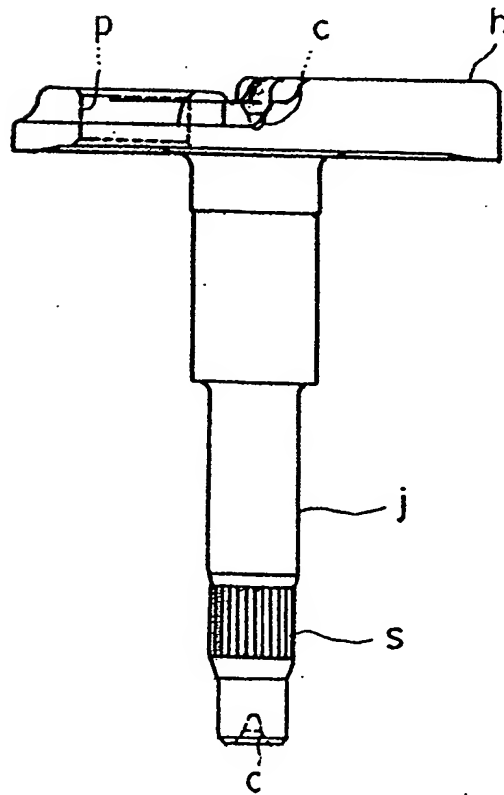


(b)

FIG. 33



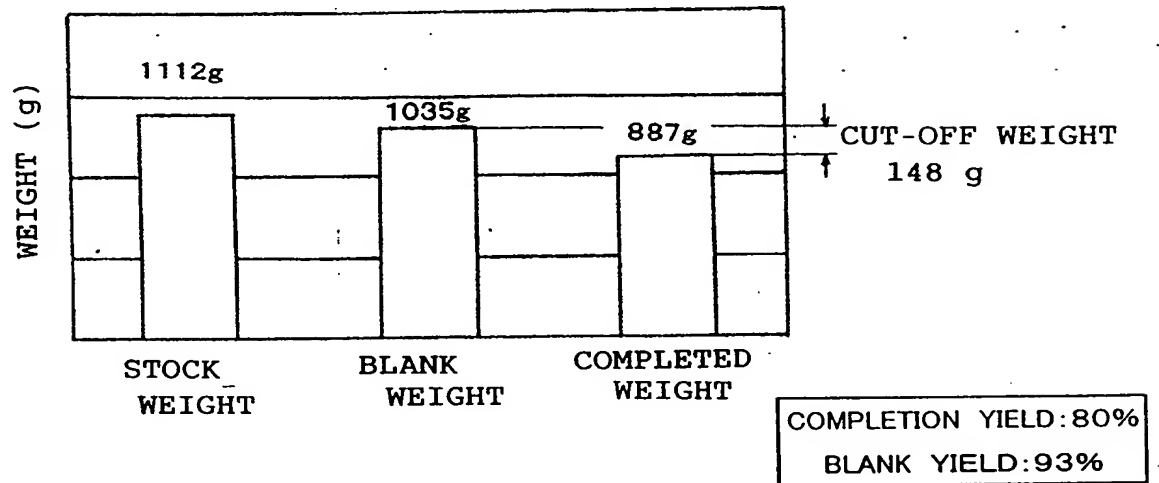
(a)



(b)

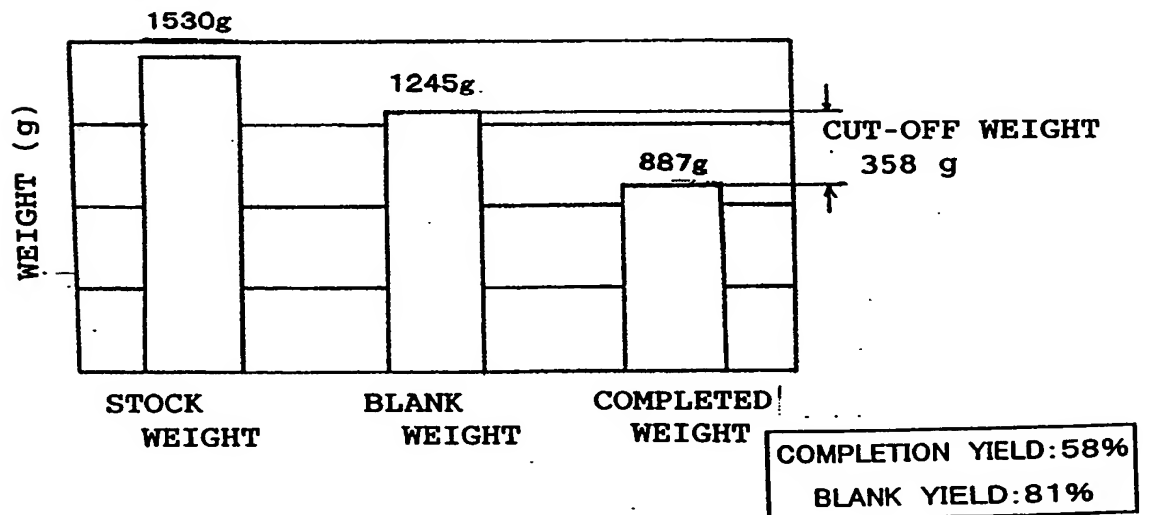
FIG. 34

(INVENTIVE COLD-FORGING METHOD)



(a)

(CONVENTIONAL COLD-FORGING METHOD)



(b)

FIG. 35

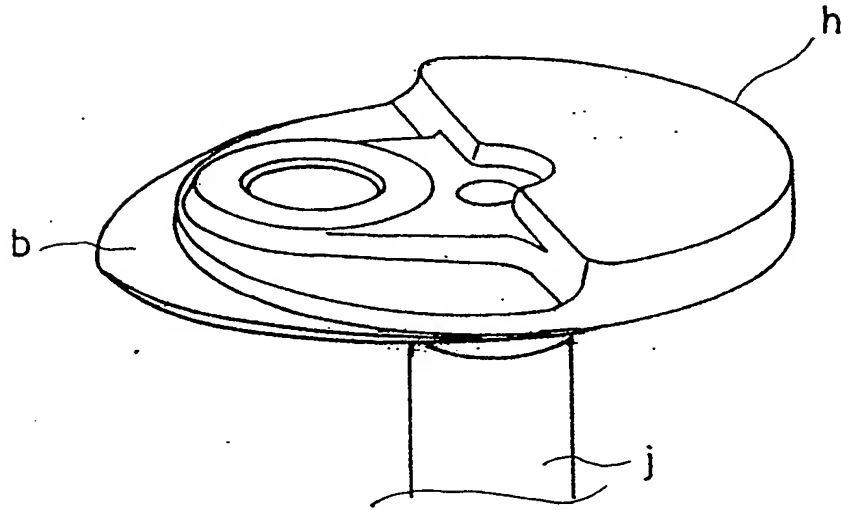
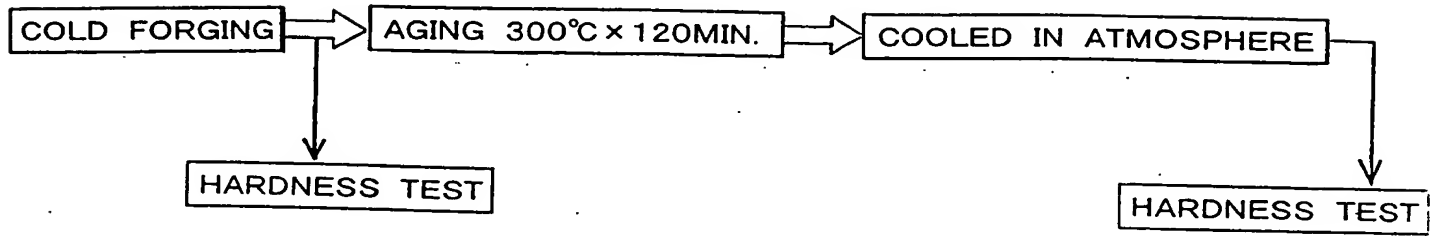
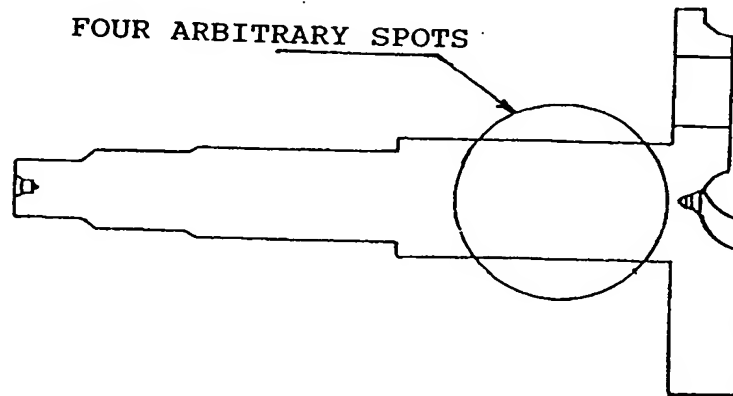


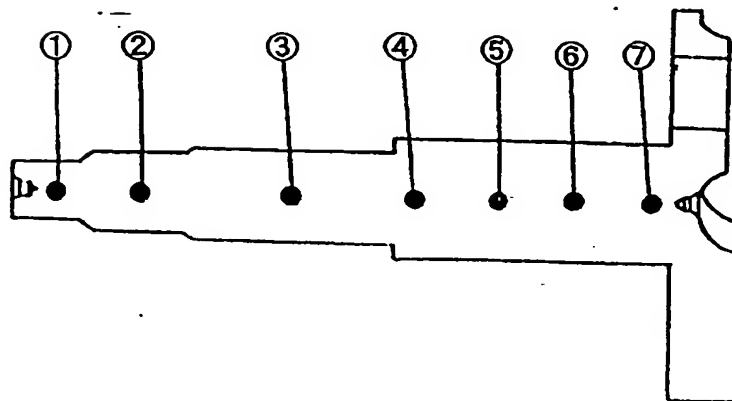
FIG. 36



(a)



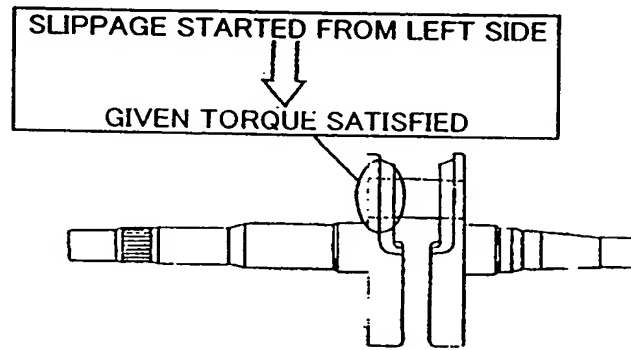
(b)



(c)

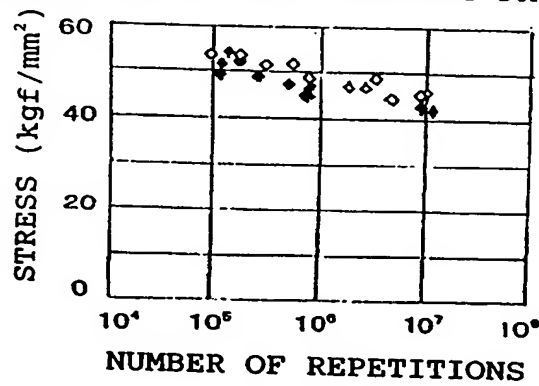
FIG. 37

SLIP TORQUE



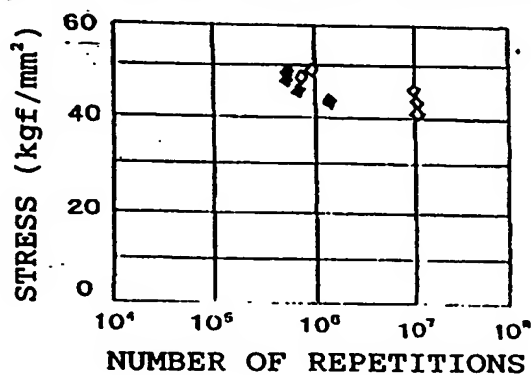
(a)

S - N CURVE (ROTATIONAL BENDING FATIGUE TEST)



(b)

S - N CURVE (SOLID BENDING FATIGUE TEST)



(c)

FIG. 38

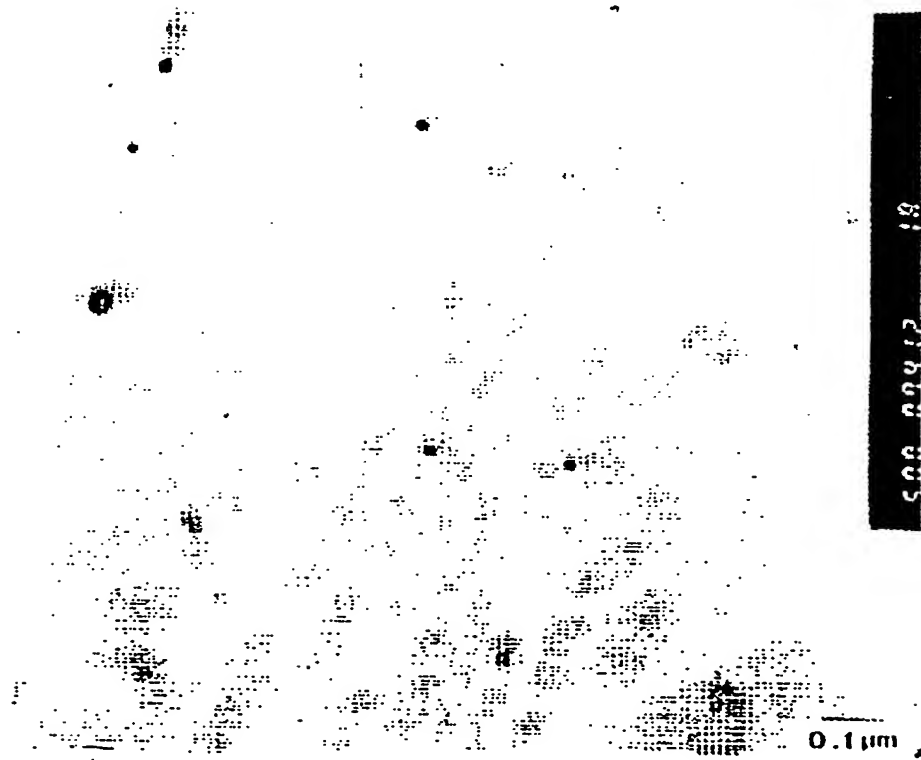


FIG. 39



FIG. 40

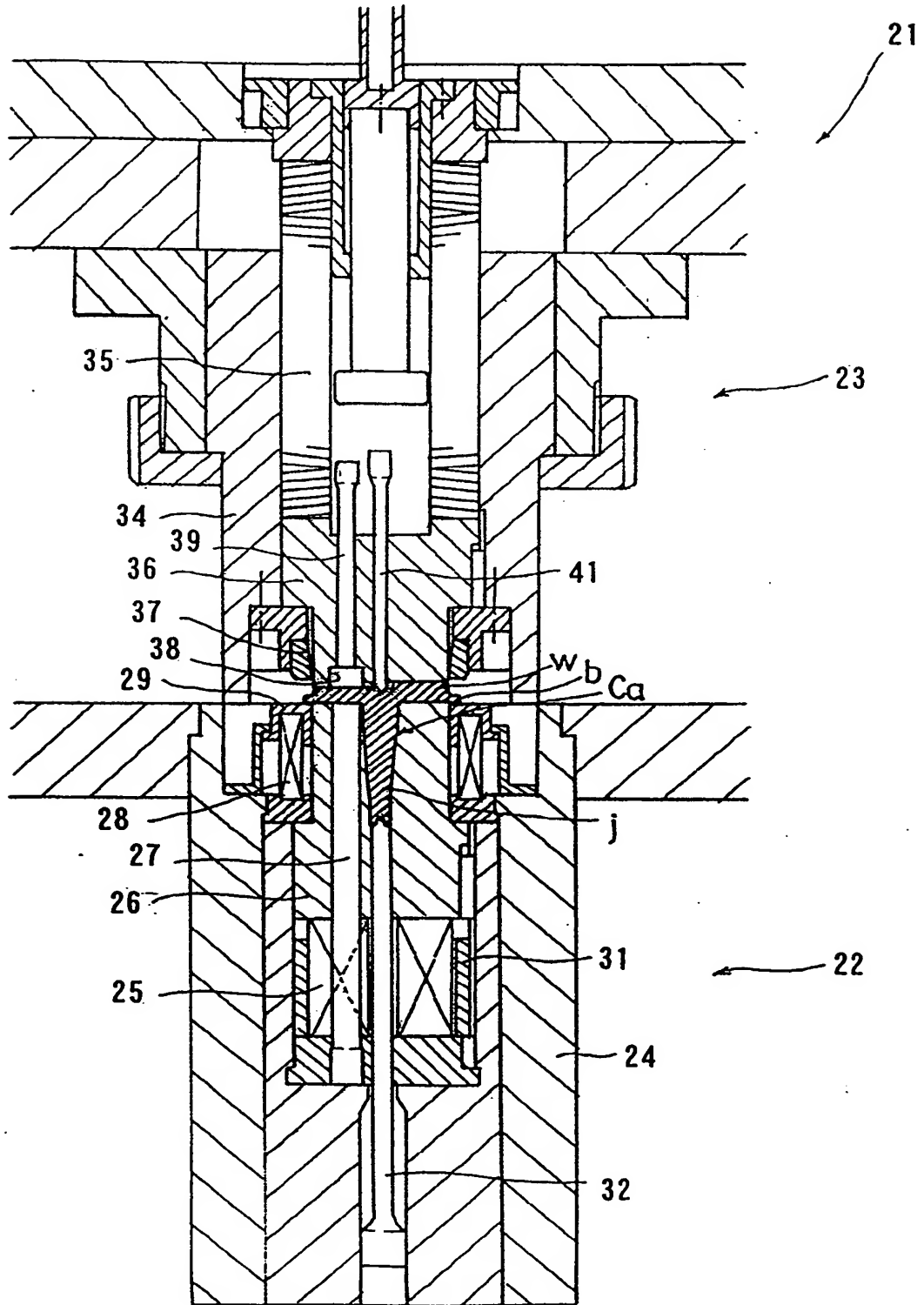
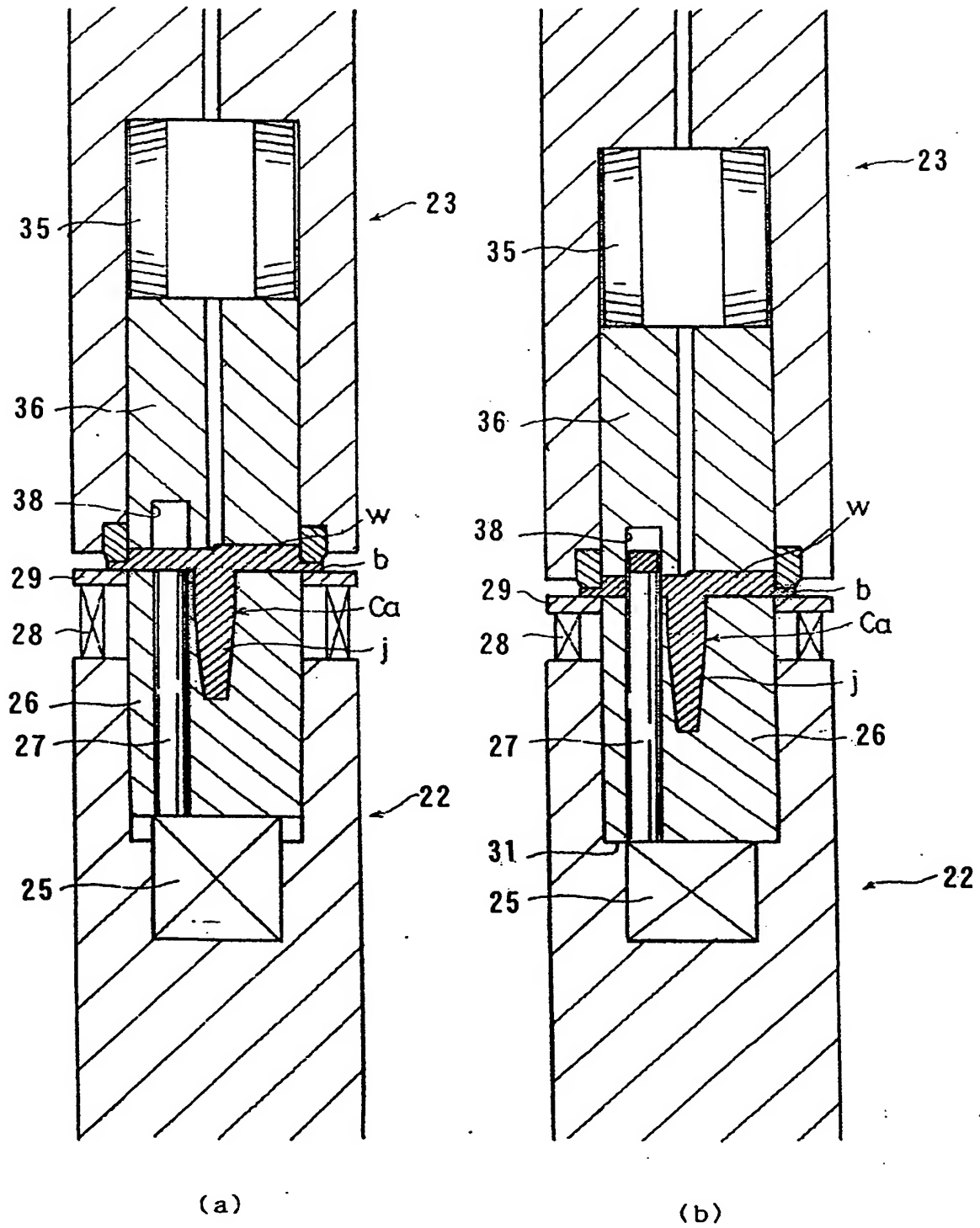


FIG. 41



(b)

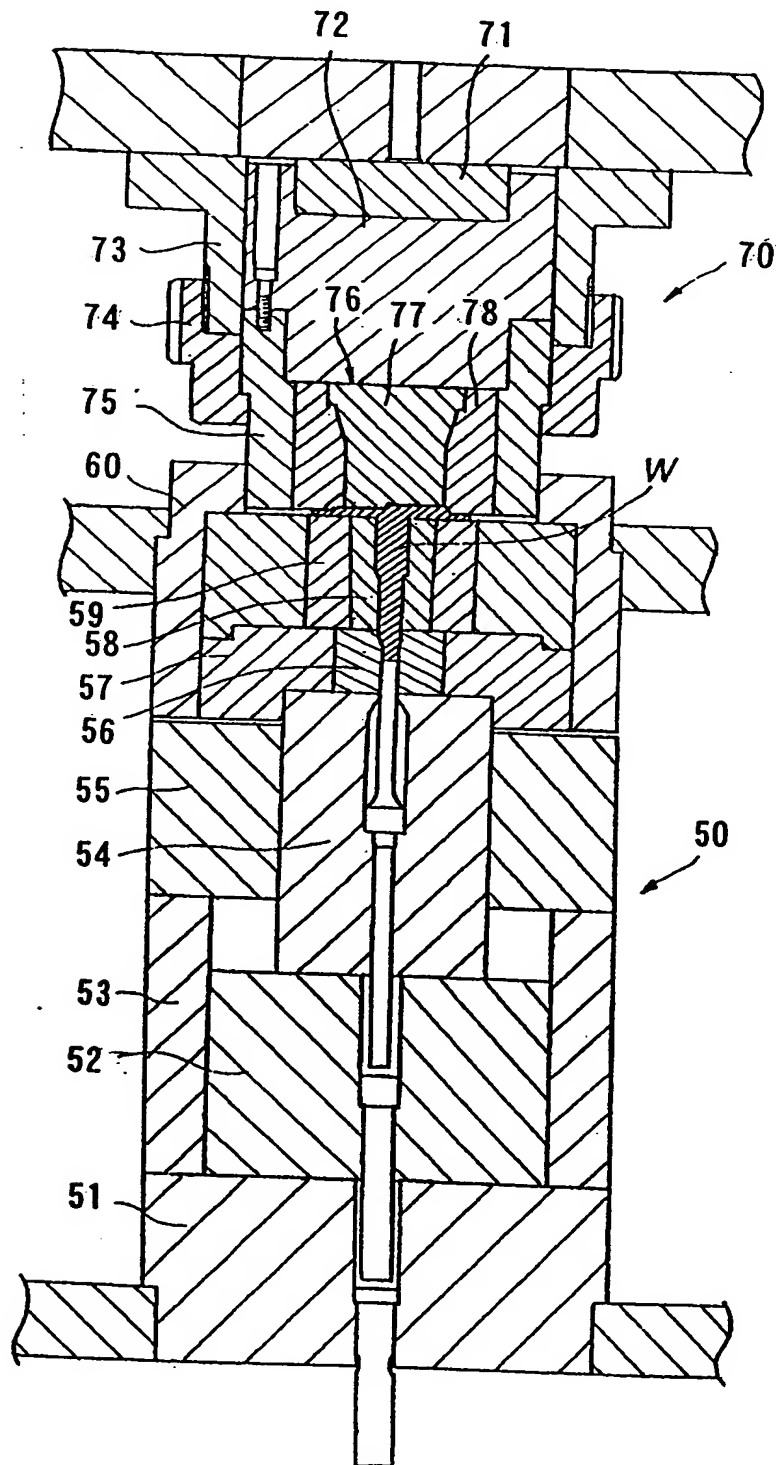


FIG. 44

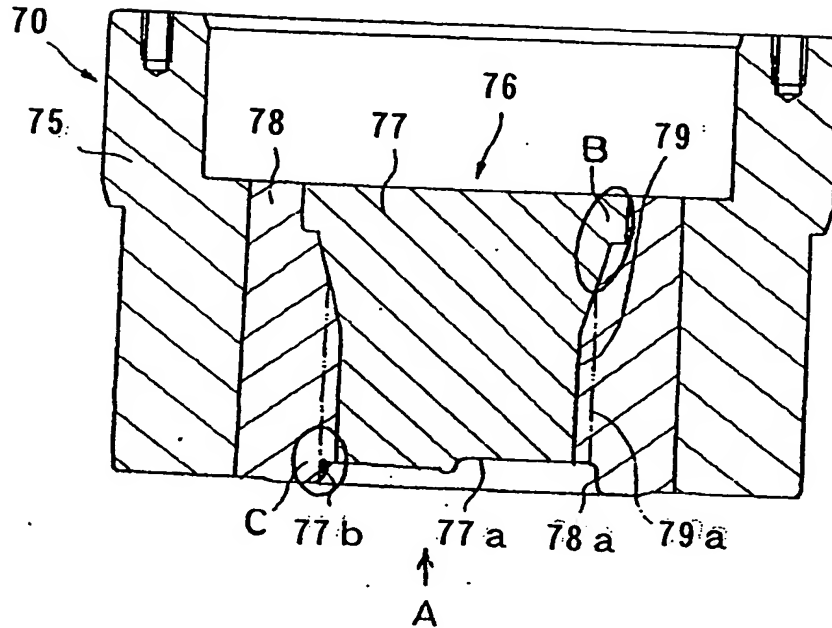


FIG. 45

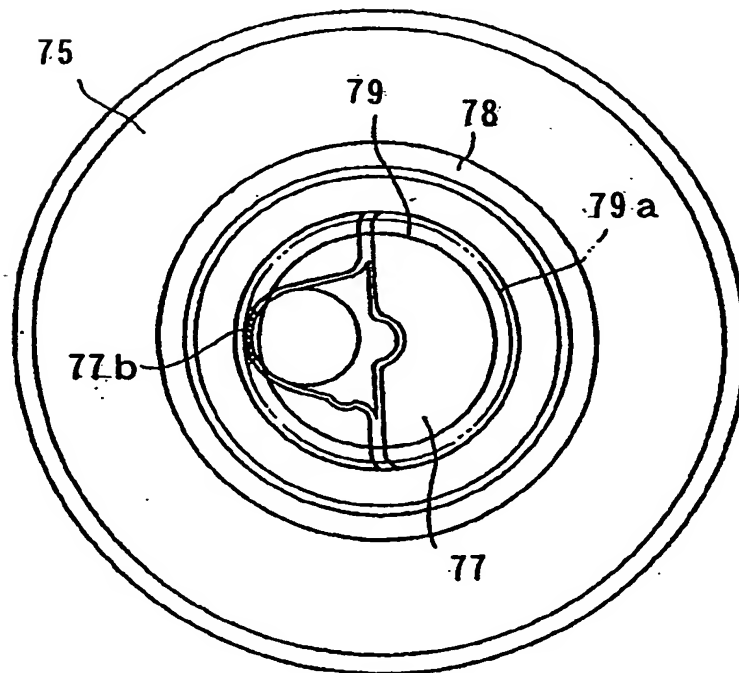


FIG. 46

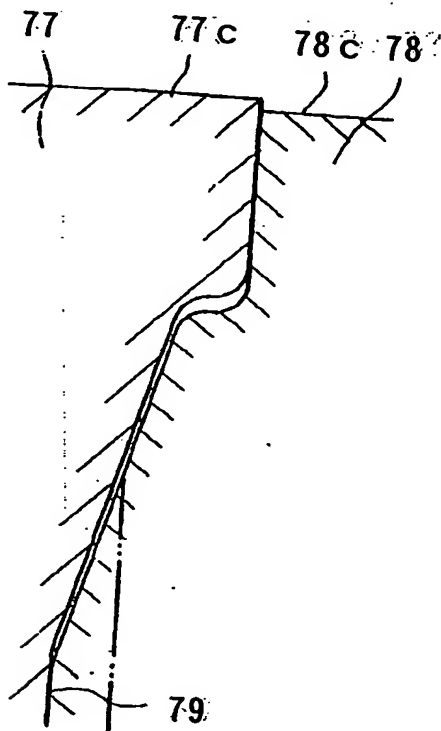


FIG. 47

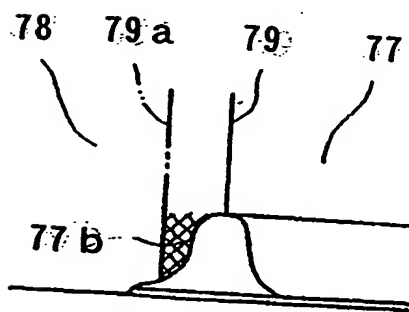


FIG. 48

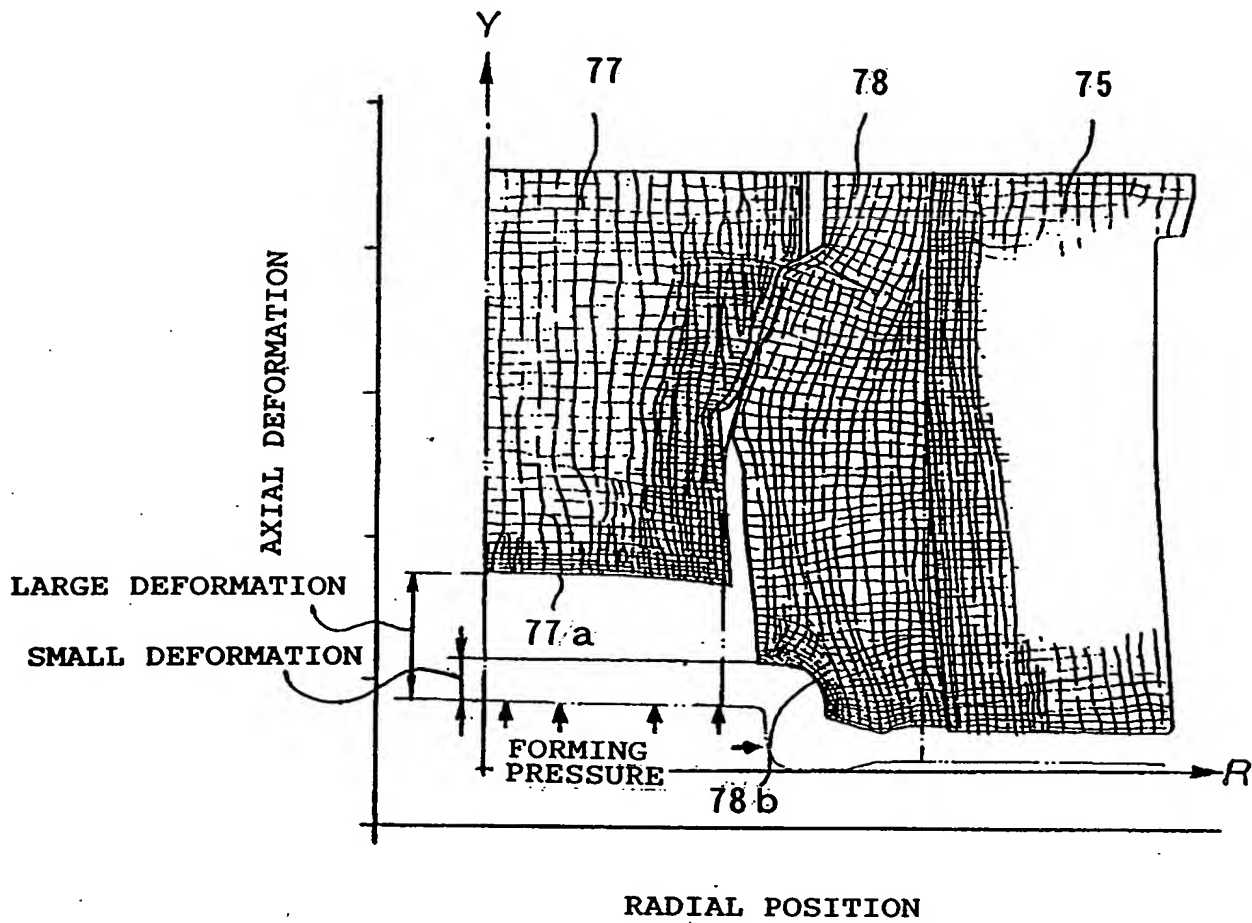


FIG. 49

	Billet manufacturing process					Aspect ratio of carbide (%)	Crack percentage % N=100
	Spherodizing annealing prio to drawing	Drawing	Cutting	Spherodizing annealing subsequent to drawing	Shot bonderizing		
Material 1	None	None	○	○	○	506	35%
Material 2	None	(20%) ○	○	○	○	347	5%
Material 3	○	(20%) ○	○	○	○	300	0%

$$\text{Aspect ratio (\%)} = b/a \times 100$$

